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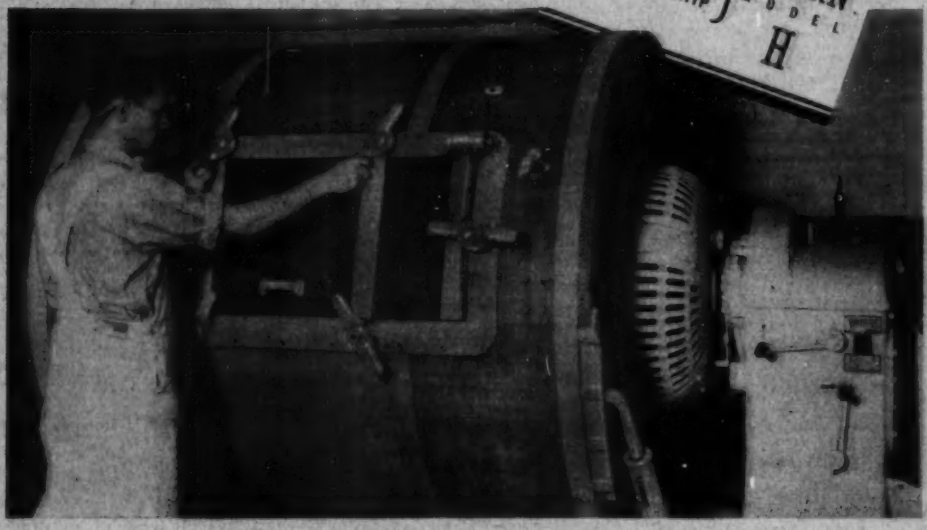

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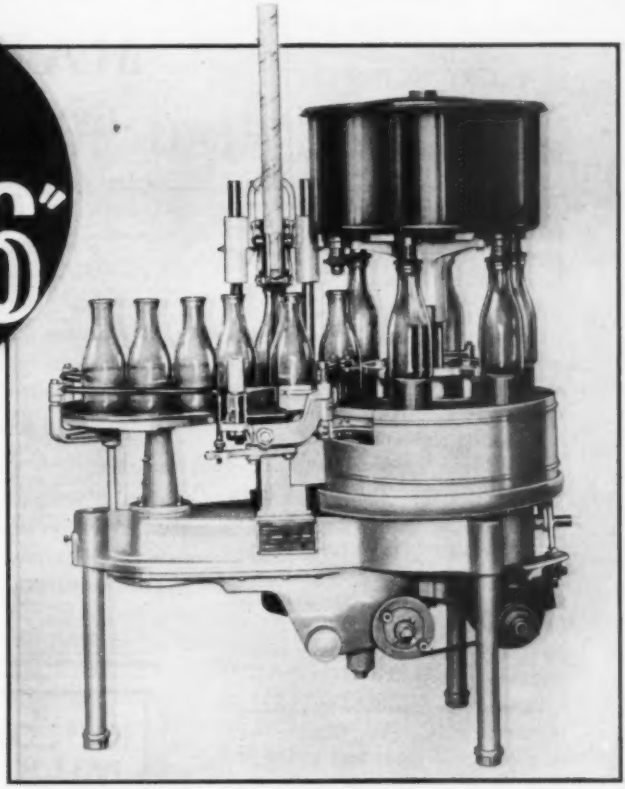

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JOURNAL OF DAIRY SCIENCE

VOLUME XXI FEBRUARY, 1938 NUMBER 2

NUTRITIONAL ANEMIA IN CATTLE IN SOUTHEASTERN MASSACHUSETTS*

J. G. ARCHIBALD AND K. J. KUCINSKI
Massachusetts Agricultural Experiment Station, Amherst
AND
R. O. BROOKE AND S. L. FREEMAN
The Charles M. Cox Company, Boston

INTRODUCTION

During the past few decades nutritional anemia among cattle has been identified in certain widely scattered but relatively restricted areas of the world. The disease under various names has been known to stockmen for a much longer time, but its cause and the effective treatment of it were first demonstrated by Aston (1) in New Zealand early in the present century. Since Aston published his findings the disease has been reported by Orr (2) from certain areas in Scotland and from Kenya colony in Africa, by Sjollema (3) from Holland, and by Becker *et al.* (4) from Florida.

The disease is variously known as "bush sickness" in New Zealand, "nakuruitis" in Kenya, "pining" or "vinquish" in Scotland, "lecksucht" in Holland, and "salt sick" in Florida. It is characterized by a general unthrifty condition, loss of appetite and consequent emaciation, and by a definite lowering of the number of erythrocytes (red cells) and of the hemoglobin in the blood of the affected animals.

In most cases an insufficient amount of iron in the soils and crops of the region has been shown to be the cause of the trouble, although at least one group of investigators has reported that the iron deficiency may be complicated by a copper deficiency (4). Generally cures have been effected by supplying iron directly to the animals as a drench (iron ammonium citrate) or by allowing them access to a mineral lick (red oxide of iron and salt).

OCCURRENCE IN MASSACHUSETTS

Early in 1934 the attention of one of us (S. L. F.) was drawn to an unusual condition in a valuable herd of Guernsey cattle on an estate bordering on the north side of Buzzards Bay in Plymouth County. The mature cows were apparently normal, but the young stock had a decidedly unthrifty

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appearance. One heifer had died, another was apparently in the advanced stages of the trouble, while several others represented less advanced stages of varying degrees of severity. The herdsman stated that the heifers had no appetite, especially for grain, and that when the trouble had progressed to its more advanced stages he could not induce them to eat grain at all.

This peculiarity suggested a clue; since the mature cows were eating liberally of grain and were not visibly affected, some deficiency in the roughage seemed indicated. Search of the literature suggested that the trouble might possibly be an iron deficiency. Accordingly samples of the hay and corn silage that were being fed were analyzed for their iron and copper content. Calcium and phosphorus were also determined to eliminate the possibility of deficiency of those elements. As a further check on the identity of the trouble the hemoglobin content of the blood of several of the animals was determined. Results of these determinations are shown in tables 1 and 2, together with some normal values for comparison.

TABLE 1

Mineral analyses of hay and corn silage which the affected cattle had been eating

SAMPLE NO.	DESCRIPTION	PERCENTAGE IN THE DRY MATTER			
		Calcium	Phosphorus	Iron	Copper
1	Hay as eaten by the cattle	.33	.20	.0087	.0011
2	Hay-residue refused by the cattle	.26	.20	.0074	not determined
3	Hay from an area a few miles distant where the trouble is unknown	.69	.28	.0111	.0014
4	Hay (presumably normal from other sections of the country)	.24	.16	.0342	
5		.19	.17	.0215	not reported
6	Hay from New Zealand where similar trouble is experienced	not reported		.0065	"
	Corn silage, from the farm in question	.25	.30	.0008	not determined
	Corn silage, average analyses	.36	.20	none on record	

The principal points which these analytical results bring out are, (1) the iron content of the roughage is somewhat below that for hays from other sections of the state and of the country where such trouble is not experienced, and (2) the hemoglobin content is somewhat below normal in the blood of the animals visibly affected by the disease.

On the basis of these results a recommendation was made to the manager of the farm in question that as an emergency measure he administer to the affected animals a daily dose of readily available iron. This was given as a

TABLE 2

Hemoglobin content of the blood of several heifers in the affected herd

HEIFER NO.	HEMOGLOBIN FOUND (GMS. PER 100 CC. OF BLOOD)	PERCENTAGE OF NORMAL*	REMARKS
1	9.6	79.3	In advanced stage of the disease.
2	8.8	72.7	Affected but not so far advanced as #1.
3	9.8	81.0	Showing some symptoms.
4	12.2	100.8	Apparently normal.

* Normal = 12.1 grams of hemoglobin per 100 cc. of blood—a tentative standard obtained by averaging values for the blood of heifers as reported in a compilation by Neal and Becker representing 70 analyses (5).

Hemoglobin was determined with a Hellige colorimeter according to the method described in a booklet published by the makers of the instrument (Hellige, Inc., New York), in November, 1931. The method was developed by Wintrobe and Miller, of Johns Hopkins Hospital, Baltimore, Maryland.

drench in the form of a solution of iron ammonium citrate, one-half pound to a gallon of water,[1] two fluid ounces being the daily dose. As indicated in figures 1 and 2, the animals made a phenomenal recovery.

In order to prevent recurrence of the trouble it was further recommended that a change be made in the type of roughage fed. Alfalfa and grass hay

[1] Strength recommended by Becker *et al.*, in Florida Experiment Station Bulletin 231.

FIG. 1. HEIFER SUFFERING FROM AN ADVANCED CASE OF "NECK AIL." PHOTOGRAPH TAKEN IN MARCH, 1934. THE BLURRED WHITE SPOTS ON THE JAW, NECK AND SIDE ARE WHERE HAIR HAD COME OUT.

not grown on the farm were substituted for part of the home-grown hay and no further trouble has been reported.

Contemporaneous with the investigation of this particular case inquiries were made of farmers in the surrounding territory in an endeavor to ascertain the extent of the trouble. Specific cases of the trouble were found on two other farms, one located in an adjoining township, the other several miles distant.

FIG. 2. THE SAME HEIFER IN MAY OF THE SAME YEAR, AFTER RECEIVING A DAILY DRENCH OF IRON AMMONIUM CITRATE FOR TWO MONTHS. SHE GAVE BIRTH TO A NORMAL CALF THE FOLLOWING OCTOBER; WHEN SEEN AT THAT TIME SHE WAS IN EXCELLENT CONDITION AND WAS MILKING OVER 30 POUNDS DAILY.

Old residents of the region told of a condition formerly quite prevalent among their cattle which they termed "neck ail," the symptoms of which, judging from the description they gave, were very similar to, if not identical with the trouble described above. The name originates, not, as one might suppose on first hearing it, from any tendency of the disease to affect the necks of the cattle, but in the observation made by an earlier generation of farmers that cattle succumbed to it when confined in their grazing to, or when fed roughage grown on, the "necks" of land that run out into the bays, a common feature of the topography of the region.

It appears that among the local residents certain areas have been definitely recognized for many years as centers of the trouble. Formerly attempts to winter cattle in these areas on home-grown roughage resulted in such a high incidence of the disease that it became common practice to send

the cattle to other so-called "healthy" areas for the winter. The change either prevented the onset of the disease, or if the animals were already subject to it, a complete recovery was soon noted. Generally the "neck ail" areas occurred on shore farms, while for the most part the "healthy" areas were several miles inland.

Other expedients for combatting the trouble were also brought to light. One individual reported that it had been his practice to burn lumps of copperas (iron sulphate), grind it fine and mix it with the grain for his cattle. Another one said that having been troubled for years with "neck ail" among his cattle he recently discovered that he can control it by feeding a certain proprietary condition powder. He stated further that a neighbor uses the same powder sometimes and has no trouble, but tries to get along without it at other times only to have the disease reappear.

Since this man's experience suggested a further clue, a pound box of this particular condition powder was purchased in the open market and subjected to chemical analysis. Among other things it was found to contain 5.6 per cent of iron (equivalent to 8 per cent of red oxide of iron, Fe_2O_3) but not more than a trace of copper. The presence of the iron oxide was evident even from superficial examination, the material being brick red in color.

A number of those interviewed emphasized the fact that the trouble was more prevalent formerly than it has been of late years. Two factors in the situation suggest an explanation for this: (1) the number of cattle in the region is much less than it used to be, and (2) more imported hay is fed.

ADDITIONAL ANALYTICAL STUDIES

This fund of supporting information was then supplemented by further analyses of hays and soils of the region for their iron content. A summary of the results together with appropriate comparisons appears in table 3.

In general these results show a much higher iron content in both hay and soil from farms where the trouble is unknown than from those where definite cases of "neck ail" have been found. The percentage of iron in Hay ♯4 was almost exactly double that found in either ♯2 or ♯5. The salt hay (♯3) had over ten times as much iron as either of these two. It is possible that some of this may have been from adherent soil due to tide flowage.

The soils from the "neck ail" areas were decidedly low in total iron. Even the "healthy" soil contained only about a third as much as the average found in a number of soils of this state several years ago. The available iron (as determined by solution of the soil in 5 per cent oxalic acid) was roughly proportional to the total amount found, being of the order of 5 per cent or less of the total. The proportion of it is slightly higher in the soils from farms where no trouble occurred. Apparently there is no correlation between the availability of the iron and the pH of the soil.

TABLE 3

Percentages of iron in some hays and soils of the region

SAMPLE NO.	DESCRIPTION	TOTAL IRON %	AVAILABLE IRON %	AVAILABLE IRON AS % OF TOTAL	pH OF SOILS
1	Hay—same as in Table 1	.0087	.....	.....	.....
2	Hay from another farm where "neck ail" was noted	.0107	.....	.....	.....
3	Hay—salt hay from a shore farm in the same region, free from the trouble	.1091	.....	.....	.....
4	Hay from a farm in the so-called "healthy" area a few miles inland	.0213	.....	.....	.....
5	Hay from a 3rd farm where a case of "neck ail" was found more recently	.0107	.....	.....	.....
1	Soil on which Hay #1 was grown	.608	.0224	3.7	5.65
2	Soil on which Hay #2 was grown	.246	.0098	4.0	4.65
3	Soil from same farm as Hay #3, but not the identical soil	.577	.0326	5.7	5.70
4	Soil on which Hay #4 was grown	1.048	.0504	4.8	5.60
	Average of a number of Mass. soils	2.905	.....	.....	.....

Additional notes on soils.

#1. From a shore field; surface soil—dark brown sand, 8"–12" deep; subsoil—orange yellow sand; luxuriant growth of grasses.

#2. Grey sand, 4"–6" deep; orange sandy subsoil, sorrel very thick; much yellowing of grass and clover.

#3. Black sandy loam, almost a muck; 8"–12" deep, gray sand subsoil.

#4. Dark brown sandy loam, 8"–12" deep; orange sandy subsoil; good grass.

As indicated in the footnotes to table 3, the two soils (1 and 2) from farms where specific cases of the disease were found are sands, while the other two (3 and 4) would be classed as sandy loams. This is in agreement with the work of Bryan and Becker (6) in Florida who report over twice as much silt and clay in samples of the surface foot of soil from the "healthy" areas as in similar samples from areas where nutritional anemia is prevalent. It may help to explain in part why the trouble is unknown on the farm from which soil #3 came. Although this soil has slightly less total iron that soil #1 has, the available iron is somewhat higher. It is believed, however, that more probable reasons for the absence of "neck ail" on this farm, located at the approximate center of the affected area, are to be found in the following facts: (1) the owner feeds considerable salt hay, which as already noted carries a lot of iron (whether extraneous iron or not probably matters not in practice), and (2) he buys considerable hay that

has been grown elsewhere. Incidentally impartial outsiders who know the region rate him as one of its best farmers.

Reviewing all the foregoing evidence—the outward symptoms of the disease, the lowered hemoglobin content of the blood of the affected cattle, the comparatively low iron content together with an apparently adequate copper content of the hay they had been eating, the phenomenal recovery of the animals when an iron compound was administered, the experience of old residents and their methods of controlling the trouble, the low total iron content of the soils from affected farms, and the much higher iron content of soils from unaffected regions—it seems reasonable to conclude that the disease locally termed "neck ail" is identical with the nutritional anemia described under various names from other parts of the world; that it is caused by iron deficiency in the roughage, uncomplicated by copper deficiency as is sometimes the case; and that this in turn is due to a low content of iron in the soils on which the roughage is grown.

FURTHER SOIL STUDIES

Having reached the above conclusion the next logical step was to ascertain whether the iron content of the roughage grown on such soils could be increased by the addition of iron compounds to the soil.

Bulk samples of the soils mentioned in table 3 were secured and with them a series of pot experiments was set up under controlled conditions at the experiment station in Amherst[2] according to the following plan.

Soil #1—Pot A—Check—no fertilizer.
Pot B—Complete fertilizer.
Pot C—Complete fertilizer plus iron.

The same arrangement for all four soils replicated once made a total of twenty-four pots. The fertilizer materials used and rates per pot were:

Sodium nitrate	1.52 grams.
Ammonium sulphate	1.18 grams.
Mono-calcium phosphate	.89 gram.
Potassium sulphate	.92 gram.

These amounts furnished acre equivalents of 200 lbs. each of nitrogen (N), phosphoric acid (P_2O_5), and potash (K_2O). All chemicals used were Merck's C.P. grade to obviate possibility of introducing traces of iron. To those pots scheduled for an addition of iron it was supplied in the form of ferric ammonium citrate, 1.46 grams per plot. This was the equivalent of 100 lbs. of elemental iron (Fe) per acre. The soil in the pots was kept at a uniform moisture content by the daily addition of weighed amounts of distilled water in accordance with their moisture-holding capacity.

[2] Acknowledgment is made of the cooperation of the Department of Agronomy of the Massachusetts State College, whose greenhouse and laboratory facilities were utilized for this phase of the work.

The crop grown was a mixture of timothy and red top, an approximately equal number of seeds of each species being used. The seeding was done in the autumn; because of the shortness of the days, growth was slow until the following spring. Probably this was not a disadvantage as it is similar to the procedure followed in this state, of seeding grass for mowings in August or September. Probably because of thickness of stand, the plants did not reach the flowering stage and were harvested the latter part of June.

Average yields are reported in table 4.

TABLE 4

Calculated acre yields of air-dried grass from treated soils

SOIL*	CHECK (TONS PER ACRE)	COMPLETE FERTILIZER (TONS PER ACRE)	COMPLETE FERTILIZER + IRON (TONS PER ACRE)
#1	1.7	3.8	3.1
#2	2.3	5.3	5.7
#3	1.4	5.9	5.7
#4	2.3	6.0	5.9

* See footnote, table 3, for identification.

The yields in table 4 show a decided response to the use of complete fertilizer either with or without iron. This is not surprising on soils as sandy in nature as these are, especially in view of the fact that the soil samples were obtained in October, at which time of the year much of the plant food applied the previous spring would have been removed either by the growing crop or by leaching.

In general the addition of iron ammonium citrate resulted in a small decrease in yield when compared with complete fertilizer without the addition of iron, but with the exception of the results for soil #1 the difference is so slight as to be within the limit of error of this type of work. It should be borne in mind, however, that iron forms insoluble compounds with phosphorus and this fact may account for the reduction in yield which occurred when the iron supplement was added. In the case of soil #2 there was a slight further increase in yield when iron was added. Incidentally this soil had much the lowest amounts of both total and available iron of any in the group (see table 3).

Of greater interest than the yields of grass are the percentages of iron resulting from the soil treatments. These appear in table 5.

The use of a complete fertilizer brought about only a small average increase over the check in the percentage of iron in the grass (less than 5 per cent); in fact in two cases (soils 1 and 4) there was a decrease in the amount of iron in comparison with the control. The addition of an iron compound resulted in a uniform and consistent large increase in the iron content of the grass, the average being almost 58 per cent. The average

TABLE 5

Percentages of iron in air-dry grasses after application of soil amendments

SOIL	WITHOUT TREATMENT	WITH COMPLETE FERTILIZER	WITH COMPLETE FERTILIZER PLUS IRON	PERCENTAGE INCREASE IN IRON	
				Over check	Over complete fertilizer
	%	%	%	%	%
#1	.0257	.0239	.0394	53.3	64.9
#2	.0309	.0404	.0492	59.2	21.8
#3	.0232	.0254	.0369	59.1	45.3
#4	.0294	.0248	.0468	59.2	88.7
Average	.0273	.0286	.0431	57.9	50.7
Average percentage increase over check		4.8	57.9		

amount of iron in the controls was .0273 per cent which increased to .0431 per cent when iron was supplied as iron ammonium citrate.

When compared with the values for iron in hay grown on these soils as reported in table 3, the values for the controls are seen to be much higher. The discrepancy, however, is only apparent; the values in table 5 are for relatively immature grasses grown under ideal conditions, while those in table 3 are for mature hays, at least one of which was overripe and woody when cut. Also the general conditions under which the two sets of values were obtained are not at all comparable.

The important point which these values show is that the addition of iron to these iron-deficient soils has resulted in a marked increase in the iron content of vegetation grown on them, and as seen in table 6, has greatly increased the supply of iron available for future crops.

TABLE 6

Residual amounts of available iron in the soils after the grass was harvested

SOIL	WITHOUT TREATMENT	WITH COMPLETE FERTILIZER	WITH COMPLETE FERTILIZER PLUS IRON	PERCENTAGE INCREASE IN IRON OVER CHECK
	%	%	%	%
#1	.0215	.0844	.1076	400.5
#2	.0164	.0235	.1765	976.2
#3	.0365	.0437	.1554	325.8
#4	.0598	.0738	.2039	241.0
Average	.0336	.0575	.1609	378.9
Average percentage increase over check		71.1	378.9	

It would seem, therefore, that the addition of iron compounds to the soil of regions in Massachuetts where nutritional anemia occurs, offers an alternative method in the treatment of this disease—a method that in the long run probably would be cheaper and more practicable than direct dosage of the affected animals with iron or the purchase of feed from unaffected areas.

SUMMARY

A disease of cattle locally known as "neck ail," of long standing in certain localities of southeastern Massachusetts, has been described and shown to be identical with nutritional anemia of cattle occurring in various widely scattered portions of the world and known by various names.

The disease is characterized by emaciation, loss of appetite, and a diminution in the red blood cells and in the hemoglobin content of the blood of affected animals.

It is caused by an insufficient amount of iron in the native forage which in turn is due to a very low content of iron in the soils on which the forage is grown.

As with cases reported by other investigators, spectacular recovery has followed the administration of iron compounds to the affected animals.

Addition of an iron compound (iron ammonium citrate) to soils from farms where the disease had occurred, resulted in a uniform large increase in the percentage of iron in grasses grown on these soils. This suggests an alternative method for prevention of the disease.

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Note: After this work had been completed and while the data were being prepared for publication, there came to our attention the recent work of Denham in New Zealand and of Filmer and Underwood in Australia. These investigators have shown that it is a lack of minute traces of cobalt that causes the particular type of nutritional anemia known in those countries as "bush sickness."

THE EFFECT OF THE RIPENING PROCESS ON THE VITAMIN A CONTENT OF CHEDDAR CHEESE*†

N. B. GUERRANT AND R. A. DUTCHER
Department of Agricultural and Biological Chemistry
AND C. D. DAHLE
Department of Dairy Husbandry, Pennsylvania State College

Various types of cheese have long been recognized as valuable adjuvants to the human dietary. Among the several types of cheese used for human consumption, the whole milk cheeses merit special consideration. This is because these cheeses, in addition to being excellent sources of certain minerals and proteins of high biological value, are rich in milk fat. This is especially true of the whole milk cheeses.

Those cheeses which contain relatively large percentages of milk fat might be expected to be rich sources of vitamin A. In fact, a few data have appeared in scientific literature (Cook and Axtmayer (1), Coward and Morgan (2)) which indicate that the Cheddar cheese is an excellent source of this vitamin. There appear to be no data available, however, concerning the relationship of the vitamin A content of the fresh cheese curds to the vitamin A content of the marketable product. Nutritional investigators, working along other lines, have reported that the actions of certain enzymes and bacteria are definitely destructive to carotene and to vitamin A. From such reports it might appear that the vitamin A content of the ripened cheese is only a fraction of the vitamin A content of the products incorporated into the cheese. Since different types of cheese, as well as different batches of the same type, are cured for varying periods of time, depending upon various factors, it would appear that those cheeses which had been subjected to the longer periods of curing and storage should have undergone the greatest depreciation in their vitamin A content. In such cases, the rate and extent of vitamin A deterioration should undoubtedly depend upon a number of factors.

Since several types of cheese are known to contain appreciable quantities of vitamin A, and since no data were available concerning the stability of the vitamin A of cheese during the ripening process, it was believed that a study concerning the changes in the vitamin A content of Cheddar cheese during the ripening process would yield data of value.

EXPERIMENTAL

The investigation herein reported was restricted to a study of the stability of the vitamin A of Cheddar cheese during the ripening process. The cheese

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used in these studies was a portion of a regular batch of Cheddar cheese which had been manufactured in the usual manner by the Department of Dairy Husbandry. This cheese was made from the regular run of raw milk which had been produced during the early days of March. A representative sample of cheese was taken for vitamin A assay at the time the cheese was placed in the ripening chamber and similar samples were taken at intervals during the ripening process. The moisture content of each sample of cheese was determined just previous to the beginning of the assay. During the period of assay, the cheese was maintained in an air-tight container which in turn was kept in an electric refrigerator.

The vitamin A assays were carried out according to the U. S. P. technic (3) with the exception that the assay period was extended to 35 days. Each test animal was maintained at all times in an individual metal cage and was given the usual care and attention indicated by the above technic. The assay groups consisted of from six to twelve carefully selected test animals. Extreme care was exercised in distributing litters, sexes and body-weights uniformly throughout the several assay groups.

Preliminary studies with the original cheese curds at the beginning of the ripening period indicated that daily doses ranging from 0.1 to 0.4 gram were sufficient to insure satisfactory growth and at the same time made sufficient allowance for marked destruction of vitamin A during a prolonged ripening process. Therefore, this range of daily allotments was adopted. Carefully weighed quantities of cheese were fed, in separate containers, to vitamin A deficient animals. While the assays were in progress, a comparable group of animals was being fed a definite unitage of vitamin A in the form of the U. S. P. reference cod-liver oil. It may be stated in connection with the weighing of the daily portions of cheese that these portions were always taken from a freshly cut surface in order to minimize the effect of moisture losses during the assay period.

DATA

Data obtained as the result of this series of assays have been condensed and are presented in the following graphs (Figure 1).

DISCUSSION

From the data presented in the above graphs it appears quite evident that the vitamin A content of Cheddar cheese does not change appreciably during a combined ripening and storage period of one year. A period of this duration is somewhat longer than that commonly used in practical cheese-making. It appears safe, therefore, to conclude that there is no serious loss in the vitamin A potency of such cheese during the usual curing period.

While the data, as presented above, indicate only a slight decrease in the vitamin A potency of the cheese as a result of the ripening process, this decrease becomes somewhat more significant when the growth responses are adjusted for the difference in moisture content of the various cheese samples

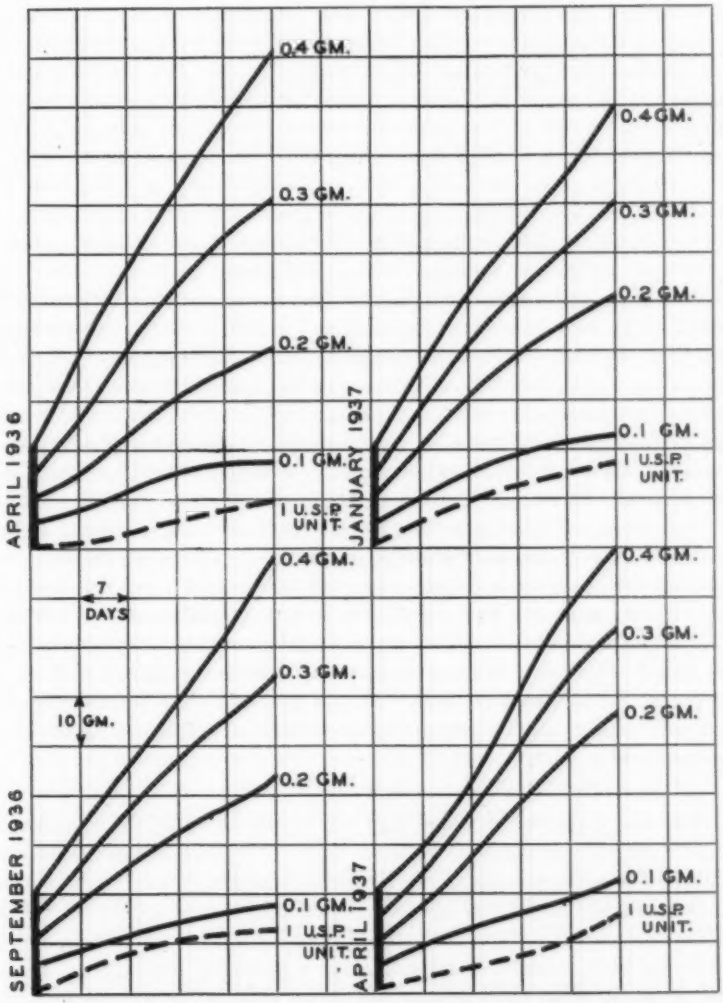

FIG. 1. Growth responses resulting from feeding definite weights of Cheddar cheese, which had been ripened for different periods of time, to groups of vitamin A deficient rats as the only supplement to a vitamin A deficient diet, are given. Corresponding growth responses resulting from feeding a definite unitage of vitamin A in the form of the U. S. P. reference cod-liver oil are also given.

at the time of assay. The moisture content of the four samples of cheese at the beginning of the assay was 37.36, 33.25, 30.29 and 30.00 per cent, respectively. Owing to moisture losses, the amounts of moisture-free cheese fed

at the second and subsequent assays were larger than those fed during the initial assay and, therefore, should have produced greater growth responses if there had been no vitamin A destruction. Since the growth responses obtained in the above studies were somewhat less, in spite of the slight increase in the amounts of moisture-free cheese fed, it can only be concluded that there had been a measurable amount of vitamin A destruction during the ripening process. But since these losses in vitamin A potency were so nearly compensated for by the decrease in moisture content of the cheese, the loss in vitamin A units per unit weight of cheese to the purchaser, as a result of the ripening process, appeared to be insignificant.

According to the above data, the finished cheese contained approximately 4500 U. S. P. units of vitamin A per pound. This potency is somewhat less than that reported for Cheddar cheese by other investigators. This difference in potency is believed to be due to differences in vitamin A intake of the cows producing the milk from which the cheese was made. It has long been known that the vitamin A content of milk (milk fat) depends upon the vitamin A intake of the cow producing it. The cheese used in these studies was made from milk which had been produced during the month of March, at a time when the vitamin A intake of the cow is relatively low as compared to other seasons of the year when green pasture, green feeds, etc., are available. The low vitamin A potency of the above cheese is, therefore, attributed to the low vitamin A content of the curds from which the cheese was made. When one considers the fact that cheese is often made from surplus milk and that surplus milk is usually more plentiful during the spring and summer months, it at once becomes apparent that much of the Cheddar cheese, as purchased on the market, may contain a vitamin A potency in excess of that reported above.

SUMMARY

Data are presented to show that no serious destruction of vitamin A occurs during the ripening of Cheddar cheese. While a measurable decrease in vitamin A potency was apparent, this loss was almost wholly compensated for by moisture losses. It appears, therefore, that a pound of Cheddar cheese purchased at the end of the usual ripening period will contain approximately the same amount of vitamin A as a pound of the original curds in spite of the fact that some destruction of the vitamin has occurred.

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REACTIONS OF THE DAIRY COW TO CHANGES IN ENVIRONMENTAL TEMPERATURE

W. M. REGAN
Division of Animal Husbandry
AND G. A. RICHARDSON
Division of Dairy Industry, University of California, Davis, California

It has been shown (1, 2, 3) that the dairy cow withstands long periods of exposure to temperatures as low as zero degrees Fahrenheit with little loss either in production or in the efficiency of food utilization. Temperatures in excess of 85° F. have, however, a marked detrimental effect (4). Because the researches from which these conclusions have been drawn were designed primarily to study the effect of exposure on milk production, and because they were subject to the many uncontrolled factors that necessarily accompany group experiments under conditions of practical dairy herd management, they yield little information of a fundamental nature that can be used to explain the physiological reactions responsible for the effects noted.

The installation at the California Experiment Station of an air conditioned room which is large enough to house two mature cows and in which temperature, humidity and air movement can be accurately controlled gave us facilities for a more precise consideration of some of the physiological reactions of high-producing cows to changes in psychrometric conditions. Six pairs of animals, including representatives of the Holstein, Jersey, and Guernsey breeds have been studied under varying conditions for periods of from three to five months. The rectal temperature, pulse, and respiration rate, together with the amount of feed and water consumed, were recorded twice daily for each animal. The physico-chemical properties of the milk were also determined. Except for changes in environmental temperature, uniform conditions were established. An air velocity of 50 feet per minute as measured by the kata thermometer and a relative humidity of 60 per cent were maintained. All cows were given a standard diet fed in accordance with their individual needs. Free access to drinking water was provided at all times.

The cows were held at each temperature for a period of from 5 to 10 days. The data for the first 2 days of each period were, however, not included in the averages, thus eliminating the possibility of any influence being exerted by the condition of the previous period. It will be seen, Table 1, that as the room temperature increases, there is a rise in the respiration rate and a fall in the pulse rate; the rectal temperature, however, remains constant at 101° F., until a room temperature of 70° F. is reached, after which it also rises.

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TABLE 1

Effect on respiration rate, body temperature and pulse rate of varying environmental temperatures

ROOM TEMP.* ° F.	RESPIRATIONS PER MIN.	RECTAL TEMP. ° F.	PULSE RATE BEATS PER MIN.
40	12	101.0	....
50	17	101.0	72
60	28	101.0	68
70	42	101.3	63
80	56	101.8	61
85	70	102.2	59
90	88	102.7	60
95	106	103.7	57
100	124	105.1	....

* Air velocity at 50 feet per minute.
Relative humidity constant at 60 per cent.
.... Not recorded.

As shown by Table 2, the changes in the amount of milk and in its composition and chemical and physical characteristics become marked and the trends definite as the room temperature rises above 80° F. There is a decrease in milk flow, in the percentage of solids-not-fat and in the protein content. There is a lowering of the freezing point depression and a lengthening of the time of rennet coagulation. The values for the percentage of butterfat and the pH tend, however, to increase. Between 90 and 95° F. there are marked changes in the characteristics of the milk fat, as indicated by a lowering of the Reichert-Meissl value and an increase in the iodine number.

DISCUSSION

The normal body temperature of the cow lies between 101 and 102° F. In order to maintain it within these limits, the heat produced by metabolism must equal that lost from the body. While there is some variation in the metabolic rate and, consequently, in the rate of heat production within the body in response to thermal conditions of the environment, the balance between heat production and heat loss necessary to maintain a constant body temperature is accomplished mainly through adjusting the rate of heat loss. Our data indicate that the upper limit of heat regulation for the producing dairy cow is between 80 and 85° F., depending upon the breed. When held above this temperature for more than 24 hours, heat production overbalances heat loss, the body temperature rises, and definite changes occur in the characteristics of the milk.

The heat-regulating mechanism of the cow differs markedly from that of man in several important respects. (1) Man's principal means of rapidly increasing heat loss in hot weather is through the cooling effect of the evaporation of sweat, a method not available to the cow since, except for certain limited areas, her skin contains no functional sweat glands. (2) As shown above, the cow's respiration rate and consequent elimination of heat through

TABLE 2

The influence of temperature of the environment on the physico-chemical properties of milk and milk fat

TEMP. ° F.	MILK PRODUCTION LBS. PER COW PER DAY	FAT %	SOLIDS-NOT-FAT %	CASEIN %	FREEZING POINT — ° C.	pH	RENNIN COAGULATION MIN.	RENNIN COAGULATION SEC.	MILK FAT CONSTANTS: REICHERT-MEISSL VALUE	MILK FAT CONSTANTS: IODINE NO.
40	29	4.2	8.26	2.26	0.536	6.53	4	10	28.80	30.51
50	28	4.2	8.26	2.23	.....	.....	3	50	29.36	31.53
60	27	4.2	8.06	2.08	.....	.....	4	09	28.16	
70	27	4.1	8.12	2.05	0.538	6.56	4	13	28.73	31.96
80	25	4.0	7.88	2.07	.....	.....	4	00	29.14	31.77
85	23	3.9	7.68	1.93	.....	.....	4	38	28.58	31.34
90	20	4.0	7.64	1.91	.....	.....	4	49	28.15	31.44
95	17	4.3	7.58	1.81	0.525	6.65	5	05	25.65	37.12

..... Not recorded.

the lungs increase rapidly as environmental temperature rises. By contrast, man's respiration rate, except under extreme thermal conditions, is constant. (3) While at high temperatures there is a marked acceleration of man's pulse rate, there is a slight decrease in the pulse rate of the cow.

The principal mechanism for eliminating heat from the human body, especially in hot weather, is first an increased circulation in the peripheral blood vessels, raising the temperature of the skin and thus hastening the loss of heat from it. Then, if this does not result in rapid enough cooling, perspiration begins and further loss results from the evaporation of water. There is also evidence that, at this time, there is some reduction in the amount of internal heat produced. Under conditions of high temperature, however, the regulating mechanism may prove inadequate. A rise in body temperature and a consequent speeding-up of the metabolic rate then result.

Paramount among the environmental factors governing the loss of heat from the healthy human body are the temperature, humidity and velocity of the surrounding air. For the comfort of the cow, however, humidity and air movement (except as she creates air movement through breathing) are relatively unimportant.

In order to gain a better understanding of the nature of the cow's heat regulating mechanism, we carried on an experiment to determine whether or not water was transpired through the skin. Inverted petri dishes, in the bottoms of which were fastened filter papers impregnated with calcium chloride, were taped on the rump and loin of two Jersey cows and the moisture transpired by a given area (35.7 sq. cm.) during an hour was determined. From these results it was calculated that at 84° F. and 60 per cent relative humidity, each cow transpired from her entire body surface about 1 pound of water per hour. In order to determine if this moisture resulted from sweat gland activity, the cows were thoroughly washed with distilled water, after which the chamber temperature was raised to 100° F. for 1 hour. The cows were again washed. Since this wash water gave a negative test for chlorides, we concluded that no sweating had taken place.

Our data on the relation of air temperature to the respiration rate of the cow present a very interesting study. It had been shown by others that van't Hoff's law (speed of chemical reaction approximately doubles with each increase of 18° F.) applies to the breathing rate of poikilothermous animals. Our figures for the cow fit this law remarkably well. This automatic control of temperature by breathing rate probably comprises the cow's principal method of heat regulation.

In a study of the heat dissipating mechanisms of the dog and man, Dill (7) concludes that on the whole man's is more efficient at high temperatures. In certain respects, however, he found the dog's to be superior. Since the dog and the cow have similar heat regulating mechanisms it is possible that

the points in which the dog excels may also apply to the cow. These are: (1) the absence of sweating, thus avoiding the disturbance of the water balance that accompanies the rapid elimination of salt from the body; (2) the ability to maintain an arterial carbon dioxide pressure as low as 10 mm., permitting greater alveolar ventilation, allowing for a greater dissipation of heat through the lungs, and thus avoiding the shift in circulation to the periphery which immobilizes part of the blood for gas transport; (3) the establishment of rapid air movement over significant areas through increased breathing rate.

The effect on the pulse rate is another physiological difference between man and the cow in their response to heat. While the pulse beat of the former speeds up as the "effective temperature" rises above 95° F., that of the latter tends to slow down. These facts are in thorough accord with the method of heat dissipation used by each. As stated above, man's first line of defense against a pyrexial condition is to increase the flow of blood through the capillaries of the skin; hence, an acceleration of the heart rate facilitates the elimination of heat from the body. Since the cow does not sweat, her dry skin in a hot environment may actually acquire a temperature above that of the body, in which case increasing the rate of circulation would tend to place an added burden upon the heat-dissipative mechanism while a slowing of the heart rate would be actually beneficial.

Until the cow becomes hyperthermic, her milk is quite uniform in composition and behavior. Significant changes occur in the milk after the "upper critical temperature" has been reached. These can probably be explained best on the basis of blood changes brought about to facilitate heat dissipation (5, 6, 7). The lowering of the serum protein of the blood which Dill has shown for dogs might well explain the reduced protein content of the milk of cows. The higher freezing point indicates a decrease in the soluble components of the milk. Since the cow does not sweat, the blood serum chlorides show little or no variation with increasing temperatures. This probably explains why there is so little change in the specific conductance of the fat-free portion of her milk secreted at the various temperatures. It would seem probable, therefore, that the change in freezing point noted is due to a lowering of the milk sugar content. This agrees with the observation of Lee and Scott (8) that a hot environment results in the lowering of the dog's blood sugar.

The increase in the pH of milk secreted by cows in a hot environment may best be accounted for by the decrease in the milk colloids content as affecting membrane equilibria and also by the belief of Haggard (9) that the hydrogen ion concentration of blood is decreased when the body becomes overheated. That the time of coagulation of the milk by rennin is invariably greater at the higher environmental temperatures may be partially explained

by the increased pH, although lowered calcium ion concentration may be involved.

The changes in the characteristics of the butterfat secreted at high temperatures may best be explained as the result of "hyperthermic undernutrition." In our studies anorexia invariably accompanies the onset of the pyrexial condition and the changes in the chemistry of the butterfat conform to those found by Eckles and Palmer (10). The latter authors point out that all types of underfeeding have a marked effect on the physical and chemical constants of the butterfat, including a decline in volatile acids and an increase in the olein content.

SUMMARY

The effect of environmental temperature on high producing dairy cows was studied in a large psychrometric room in which the temperature was increased from 40 to 100° F., while air movement and relative humidity were maintained at the constant values of 50 feet per minute and 60 per cent respectively. It was found that, as the room temperature was increased, there was a uniform increase in the respiration rate, which approximately doubled for each increment of 18° F.; that there was a decrease in pulse rate; and that at 80 or 85° F., depending upon the breed, a pyrexial point was reached where the animals were no longer able to maintain heat balance. As the room temperature was elevated above this pyrexial point, anorexia developed, milk flow declined, and an alteration occurred in the characteristics of the milk produced, which included a lowering of the casein and solids-not-fat content, and an increase in the percentage of butterfat. The pH of the milk was raised, the freezing point depression lowered, and a longer rennet coagulation time was required. The butterfat secreted was lower in volatile acids and higher in unsaturated components.

The cow's principal avenue for heat dissipation is the respiratory system. Her breathing varies directly with the environmental temperature, and her skin has a high insulating value. She may, therefore, adapt herself with comfort to conditions of extreme cold; a fact that helps to explain why, as found by certain research workers, exposure to zero weather brings about neither lowered production not increased maintenance requirement. It is also evident that the cow is not especially well fitted to withstand hot climates, though our studies show a distinct breed difference in this regard. Because the cow's heat regulating mechanism functions in such a radically different manner from that of man, we are not justified in applying the comfort standards worked out for man to the management of cattle. The changes in composition and physico-chemical characteristics of milk when a state of positive heat balance is reached probably result from blood changes instituted to facilitate heat disposal.

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FLUORINE STORAGE IN CATTLE BONES

ROBERT JOHN EVANS, PAUL H. PHILLIPS AND E. B. HART
Department of Agricultural Chemistry, University of Wisconsin, Madison

Fluorine ingested by the animal accumulates in the bones and teeth. Michaelis (7) has postulated that fluorine plays a part in normal calcification. However, no definite proof has been advanced as to its being essential for any physiological process, even though it is always present in bones and teeth.

Recent evidence suggests that fluorine passes through the placental membrane. This is indicated by the occasional occurrence of mottled enamel in the temporary teeth of children. Smith and Smith (10), Velu (11), and Brench and Roholm (2) have reported such cases. Under experimental conditions, by the administrations of large amounts of fluorides, fluorine has been shown to accumulate in fetus of the rat and dog (8, 6).

The question of influencing the fluorine content of milk by fluorine administration is still unsettled. Murray (8) found a passage of fluorine from the mother rat to her young through the milk, but Constantini (4) found only a minute amount in the milk of goats with subacute fluorine poisoning. Phillips, Hart, and Bohstedt (9) found little change in the fluorine in cow's milk when the cows received small additions of fluorides. Huffman (5) obtained increases in the fluorine content of cow's milk when large quantities of fluorides were fed.

EXPERIMENTAL

Bones were obtained from seven calves killed for veal and from twenty-two fetuses of different ages taken from cows which were slaughtered for beef. These were obtained from a local packing plant at Madison, Wisconsin.

The fluorine intake of the mothers of these calves and fetuses was unknown, but it was assumed to be variable. Bones from two cows which had been raised on a ration relatively low in fluorine were obtained from the University of Wisconsin herd. Two samples of commercial steamed bone meal were also analyzed. One of these was an ordinary bone meal, while the other was a specially prepared bone meal for use in baby foods.

These samples were all analyzed for fluorine by the micro-method of Armstrong (1) which is a refinement of the thorium nitrate titration method of Willard and Winter. The ash content of the bones was determined in the usual manner.

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RESULTS

The results of the analyses as given in Table I show a fluorine content of

TABLE I

F content of the bones of cattle during the developmental period expressed in parts per million

ESTIMATED AGE OF FETUS OR CALF	NO. OF ANIMALS	F RANGE	AVE. F	PER CENT ASH	F RANGE ON BASIS OF ASH	AVE. F OF BONE ASH
Embryo stage (2 to 10 weeks)	8	18–60	37	40	45–150	92
4 to 9 months	14	14–50	30	48	30–111	64
Day old calf	1		24	55		44
Veal calves	6	25–51	32	58	41–90	55
Cows (mature)	2	177–202	190	64	278–317	298
Bone meal	2	411–509	460	81	540–587	564

18 to 60 p.p.m. with an average of 37 p.p.m. in embryonic bone (2 to 10 weeks of age) and older fetuses had a bone fluorine content of 14 to 50 p.p.m. with an average of 30 p.p.m. The veal calf bones contained an average of 32 p.p.m. fluorine. Thus it appears that the bones of immature and mature calves are similar in their fluorine content. It seems clear from these data that the storage of fluorine in the bones of young calves remains quite low during the suckling period and further indicates a minimum secretion of fluorine in the milk. The bones from the mature cows contained an average of 190 p.p.m fluorine, which is six times as much as those of the calves during the suckling period.

Commercial bone meal had an average of 460 p.p.m. fluorine or 564 p.p.m. on a basis of the bone ash. This is about ten times as much as the veal and fetus bones excluding embryonic bone.

Inspection of the data presented in Table I shows that embryonic bone contained appreciably larger quantities of fluorine per unit of bone ash than fetus bones. This suggested that fluorine might be present in fetal cartilage prior to calcification. With this in mind, a sample of cartilage taken from several embryos and fetuses was analyzed for its fluorine content. On the basis of dry weight this yielded 10 p.p.m. of fluorine. Since fetal bones contain on the average 30 p.p.m. of fluorine it would seem that about one-third of the fluorine content of fetal bone originates from cartilage. The ash content of this cartilage was 10 per cent and represented 25 per cent of the ash deposited in embryonic bone. The fluorine content of the fetal cartilage ash was nearly double that found in the bones of a calf at birth. A sample of whole mature bone (cow) was extracted with 10 per cent HCl until the ash was lowered to 0.4 per cent. The residue, presumably the bone matrix, was then analyzed for fluorine. It was found that this residue contained 4 p.p.m. of fluorine. Extraction with HCl had removed the greater part of the total bone fluoride along with other bone minerals from

the residue. The ash of the residue had a fluorine content of 1,000 p.p.m. Apparently the amount of fluorine in the ash of the bone matrix was considerably higher than that found in that portion of the bone soluble in 10 per cent HCl. This was 2 to 3 times the quantity expected in a normal bone ash. The significance and relationship of these results is not known. They suggest that fluorine is either a constituent of the bone matrix or that fluorine is preferentially deposited early in the calcification process.

DISCUSSION

Chang, Phillips, Hart, and Bohstedt (3) found an average of 584 p.p.m. fluorine in the bones of three cows which they had raised on a ration relatively low in fluorine. The additions of fluorine to the ration markedly increased the fluorine in the bones. This is much higher than what we found in the cows from the University farm, but compares favorably with our analysis of bone meals.

The relatively low fluorine content of fetus and calf bones shows that under ordinary conditions there is some passage of fluorine from the mother to the fetus through the placental membrane, and also to the calf through the milk. That the passage through the placental membrane is not the same for all cows is demonstrated by the difference in fluorine content of the bones of different fetuses of the same age groups. This may either be due to differences of permeability of the membrane or to a difference in the level of fluorine intake of the mother.

The fluorine content of the calf bones indicates that small quantities of fluorine are obtained through the milk. The amount obtained may be influenced by individual variations of the mothers.

The chief storage of fluorine seems to take place after the weaning of the calf even when it is kept on a ration containing relatively little fluorine. This is shown by the 190 p.p.m. average fluorine content of the bones of the cows on a low fluorine ration contrasted to the 32 p.p.m. average of the veal calf bones. These data fall into an interesting series of ratios. If the approximate per cent ash to fluorine in p.p.m. is taken it gives a ratio of 1:1 in the case of embryonic bone, 2:1 in fetal and veal bone and 1:3 in the case of mature cattle.

SUMMARY AND CONCLUSIONS

1. Under ordinary conditions it appears that a small amount of fluorine is transferred through the placenta of the cow to the fetus.

2. As long as the main source of food for the calves is milk, their bones contain a relatively constant low quantity of fluorine. Apparently small quantities of fluorine are obtained through the milk.

3. The chief storage of fluorine in the bones of cattle occurs after weaning.

4. These data also suggest that fluorine is present in appreciable quantities in the organic matrix of the bone and in cartilage.

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RAPID METHOD FOR THE QUANTITATIVE DETERMINATION OF REDUCED ASCORBIC ACID IN MILK

PAUL F. SHARP

Department of Dairy Industry, Cornell University, Ithaca, New York

Even before the isolation and establishment of the chemical constitution of vitamin C, Tillmans (9) and his associates (10) in a series of studies were endeavoring to prove that the reducing power of plant juices as determined by titration with 2-6 dichlorophenolindophenol was due to vitamin C. Following quickly upon the determination of the chemical structure of vitamin C or ascorbic acid as it is now called, numerous papers have been published in which titration by this dye has been used for the quantitative determination of ascorbic acid.

Schlemmer, Bleyer and Cahnmann (6), Kieferle and Eisinreich (3), Birch, Harris and Ray (2), Bessey and King (1), and more recently many others have determined the amount of ascorbic acid in milk by titrating the filtrate with 2-6 dichlorophenolindophenol, after precipitating the proteins. Conditions requiring precipitation for the removal of interfering substances were discussed by Van Eekelen and Emmerie (11).

Milk apparently contains no appreciable amount of interfering substances and therefore acidified milk can be titrated directly without the removal of the proteins with perhaps more reliable results because adsorption and destruction of ascorbic acid during filtration are avoided. Duplicate determinations rarely deviate by as much as 1 mg. per liter of ascorbic acid and one person can make 40 determinations an hour. The recovery of added ascorbic acid is satisfactory provided the milk is not exposed to light except during the titration and is titrated immediately after the addition of the ascorbic acid. When 50.0 mg. of ascorbic acid per liter were added, the increase in ascorbic acid content of the milk from 5 different cows was found to be 49.7, 48.7, 50.7, 50.0, and 50.2 mg.

A detailed description of the method follows:

2-6 DICHLOROPHENOLINDOPHENOL SOLUTION

Place 0.3 gram first commercial preparations or 0.2 gram or less of later, more highly purified products of 2-6 dichlorophenolindophenol in a mortar. Grind to break up lumps and add 50 ml. of hot, distilled water. Grind further and decant through a filter into a one-liter volumetric flask. Add more hot water to the residue remaining in the mortar, and again decant onto the filter. Continue this process until the blue colored material has passed through the filter. Adjust to room temperature, and make up to the volume of one liter with distilled water.

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SULFURIC ACID SOLUTION

A sulfuric acid solution of approximately 1/10 normal is used for acidifying and diluting the milk for titration. A stock solution of 10 normal is first prepared by diluting 285 ml. of concentrated sulfuric acid to one liter with distilled water. For use, 10 ml. of the stock solution is diluted with distilled water to make a volume of one liter. Approximately 25 ml. of this dilute solution is added to exactly 10 ml. of milk.

STANDARDIZATION OF THE DYE SOLUTION

Weigh accurately, approximately 50 mg. of ascorbic acid. Place in a 500 ml. volumetric flask and make up to volume with distilled water. This solution should be used at once for standardizing the dye solution.

Introduce 5 ml. of the standard ascorbic acid solution into a 200 ml. beaker. Add approximately 15 ml. of the dilute sulfuric acid solution and 15 ml. of distilled water, and at once titrate with the dye solution to a light pink color, permanent for at least 30 seconds. Subtract from this titration value a blank determination made on the acid-water mixture brought to the same color. A blank of approximately 0.3 ml. is usually obtained. The amount of ascorbic acid in the 5 ml. aliquot, divided by the number of ml. of dye solution required, gives the mg. of ascorbic acid corresponding to 1 ml. of the dye solution. This value times 100 gives, in terms of mg. per liter, the amount of ascorbic acid corresponding to each ml. of dye solution required for the titration, when a 10 ml. sample of milk is taken for titration. The original amount of dye taken should be so adjusted or the solution so diluted that this factor falls in the limits of 5 to 8.

TITRATION OF THE MILK

Pipette 10 ml. of milk into a 200 ml. beaker. Add 25 ml. of the dilute sulfuric acid solution and at once titrate with the dye solution, using a 10 ml. burette calibrated in 0.05 ml. divisions. In titrating the milk it will be found that after a small amount of the dye is added the milk will assume a pink color. Upon standing for a few seconds, this pink color will fade. More dye can then be added. This procedure is continued until a definite pink color remains for at least 30 seconds. This is taken as the end-point of the titration. After this end-point has been reached, the pink color will remain for several minutes. A blank, which is usually about 0.4 ml., should be subtracted. This blank is determined by allowing milk to stand until the ascorbic acid disappears when a constant low value is reached. This blank may be determined by allowing cold milk to stand for several days before it is titrated. The disappearance of the ascorbic acid in the milk can be accelerated by adding enough copper sulphate to make about a mg. per liter of Cu, or by placing the milk in sunlight.

Since in the early stages the titration is slow because of the fading end-point, it is very convenient to have six burettes and titrate six samples at once. In this way the dye can be added to the samples in rotation, while waiting for fading of the color.

Calculate results to the basis of mg. of ascorbic acid per liter of milk.

PRECAUTIONS

The dye solution is not stable, and on the average will decrease about 1 per cent in strength per day. It should therefore be re-standardized at 2 to 4 day intervals, and its strength interpolated to daily values.

Dye solutions over two weeks old do not give sharp end-points and therefore should not be used.

The ascorbic acid solution is not stable under ordinary conditions. It should be used within one to five minutes after preparation.

The addition of acid to the milk accelerates the destruction of the ascorbic acid. The milk should therefore be titrated as soon as the acid is added.

The exposure of the milk to light should be reduced to the minimum required for measuring and titrating the samples. See papers by Mattick and Kon (5) and Kon and Watson (4).

EXPERIMENTAL RESULTS

This method was used in obtaining the results previously reported by Sharp (7) and by Sharp, Trout and Guthrie (8).

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FURTHER INVESTIGATIONS IN CHOPPING ALFALFA HAY AT THE TIME OF STORAGE

J. B. SHEPHERD AND T. E. WOODWARD
Bureau of Dairy Industry, U. S. Department of Agriculture, Washington, D. C.

EFFECT ON SPACE REQUIRED, TEMPERATURES ATTAINED, COLOR, FEEDING VALUE, AND LOSSES OF FEED CONSTITUENTS

In an experiment (1) conducted by the Bureau of Dairy Industry at the National Agricultural Research Center, Beltsville, Md., in 1935, two lots of field-cured alfalfa hay, one containing 25.31 per cent moisture and the other containing 27.02 to 27.42 per cent moisture, were each stored in an open mow, both in the chopped form and in the natural long form.

Excessive heating and loss of green color and carotene occurred both in the long hay and in the chopped hay. The chopped hay heated more and lost more of its green color and carotene than the long hay of the same lot. Coarsely chopped hay ($\frac{3}{4}$-inch lengths) did not reach as high a temperature or remain hot as long as finely chopped hay ($\frac{1}{4}$-inch lengths). Coarsely chopped hay was light brown in color and finely chopped hay was darker brown to nearly black in color. The black chopped hay was not so palatable to dairy cows as the greener long hay, but the brown chopped hay was fully as palatable. However, the chopped hay was lower in feeding value for milk production than the long hay.

This experiment indicated that 25 to 27 per cent moisture is too high for either chopped or long alfalfa hay stored in an open mow; that chopped alfalfa hay stored in an open mow should be lower in moisture content than is necessary for long hay; and that hay should be coarsely chopped rather than finely chopped.

The present study was conducted in 1936, with alfalfa hay containing a lower moisture content (15.80 per cent). Only one lot of hay was used, half of which was put in the hay barn in the long form and half in a coarsely chopped form. The object was to determine the effect of a low moisture content (under the conditions of storage used) on the preservation of color, carotene, and feeding nutrients in coarsely chopped and long hays. The chopped hay was stored in a compartment having a floor space of 8×12 feet. The long hay was stored in a compartment having a floor space of 12×20 feet.

First-cutting alfalfa hay was mowed June 1, raked with a side delivery rake June 2, turned with a side delivery rake the morning of June 3, and put in the mow June 3 beginning at 1 P.M. The weather while the hay was curing was warm and clear with a good breeze. It rained in the middle of the afternoon while the hay was being hauled, limiting the quantity of hay

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that could be stored under comparable conditions to six loads. This was less hay than had originally been planned for storage. Alternate loads were stored long and chopped, making 3 loads, or 3 tons of each kind of hay. The chopped hay was cut in ¾-inch lengths, and blown into the compartment. At the time of storage, the hay was 7½ feet deep in each compartment.

Samples of the hays were taken for chemical analyses, carotene analyses, and color determinations. In each compartment a ½-inch galvanized pipe was inserted at the center so that the lower end was about level with the top of the first load of hay put in. Ordinary mercury thermometers were lowered into these pipes and left there continuously except when removed for the daily temperature readings.

The hay was green, leafy, and well cured when placed in storage, and it contained only 15.80 per cent moisture. This is drier than is often the case when hay is put in the mow or stack.

METHOD OF FEEDING

Feeding was started after the hay had been in storage 150 days. Chopped and long hay were fed concurrently by the single reversal system to two groups of three Holstein cows each. The cows were fed all they would eat of each kind of hay for a 28-day period. Sufficient grain was fed in addition to provide a slight excess of total nutrients over the quantity called for by the Haecker feeding standard.

RESULTS

The Mow Space Occupied

The amount of space occupied by each hay when it was put in storage and when it was taken out is shown in Table 1. Both the chopped and the

TABLE 1

Mow space occupied by chopped hay and long hay when put in storage and when taken out

	QUANTITY OF HAY	STORAGE SPACE PER TON	DRY MATTER		
			Content	Per ton	Per cubic foot
	Tons	*Cubic feet*	*Per cent*	*Pounds*	*Pounds*
Chopped hay:					
Hay put in storage	3.17	227	84.20	1,684.0	7.42
Hay removed from storage	2.88	222	88.14	1,762.8	7.94
Long hay:					
Hay put in storage	3.04	592	84.20	1,684.0	2.84
Hay removed from storage	2.72	529	88.94	1,778.8	3.36

long hay lost a little weight, due partly to a loss of moisture and partly to a loss of dry matter. Because of settling and the higher dry-matter content, both hays contained more dry matter per cubic foot when they were taken out of storage than when they were put in.

At the time of storage a ton of the chopped hay occupied 38 per cent as much space as a ton of the long hay. When taken out a ton of the chopped hay occupied 42 per cent as much space as a ton of the long hay.

The Maximum Temperature Attained

The chopped hay reached a maximum temperature of 106° in 2 days, and in 9 days the temperature had dropped to 86° and in 16 days to 76° F. The long hay reached a maximum of 81° in 24 hours and dropped to 72° in 48 hours.

Influence of the Method of Storage on the Carotene Content

When put in storage, each hay had a carotene content of 76 parts per million on a dry-matter basis. When the hay was removed, the carotene content of the chopped hay was 20.7 parts per million and that of the long hay 31.9 parts per million. In both hays the carotene content was apparently quite uniform from the top to the bottom of the pile.

The storage period included all the summer months. Investigations by the California (2) and Arizona (3) State Agricultural Experiment Stations and by the Bureau of Dairy Industry (4, 5) have shown that over equal periods of time, alfalfa hay loses more carotene during storage at high temperatures than at low temperatures. No doubt if this hay had been stored in the fall instead of in the spring, it would have retained more of its carotene.

The Effect on the Color[1]

At the time of storage both hays were of an excellent green color. No determinations for percentage of green color were made at that time. After 5 months in storage, the long hay had 54 to 57 per cent as much green color as the greenest commercially-produced alfalfa hay, and the chopped hay had 47 to 48 per cent as much. The percentage of green color in both hays was uniform from the top to the bottom of the pile. Apparently the green color was destroyed at a slower rate than the carotene.

Influence on the Losses of Weight and of Dry Matter

The weights of the two lots of hays and of the dry matter, at the time of storage, the weights at the time of removal from storage, and the losses in weight and dry matter during storage are shown in Table 2. The chopped hay lost 4.86 per cent of its dry matter and the long hay lost 5.33 per cent. Chemical analyses of the hays made at the time of storage and after 5 months of storage, applied to the weights given in Tables 1 and 2, show that dry-matter losses in both the hays consisted principally of nitrogen-free extract, with small losses of crude protein and ash and no losses of crude fiber or fat.

[1] Color determinations were made by Carl F. Welsh, Bureau of Agricultural Economics.

TABLE 2

Weights of hay and dry matter put in storage, the weights taken out, and the losses in weights and dry matter

	CHOPPED HAY	LONG HAY
Weight of hay stored ..... pounds	6,335.00	6,080.00
Weight of hay removed ..... pounds	5,758.00	5,449.00
Loss in weight during storage ..... pounds	577.00	631.00
Loss in weight during storage ..... per cent	9.11	10.38
Moisture content of hay stored ..... per cent	15.80	15.80
Moisture content of hay removed ..... per cent	11.86	11.06
Dry matter in hay stored ..... pounds	5,334.07	5,119.36
Dry matter in hay removed ..... pounds	5,075.10	4,846.34
Loss of dry matter ..... pounds	258.97	273.02
Loss of dry matter ..... per cent	4.86	5.33

The Effect on the Feeding Value

The cows used in this experiment had been on pasture until October 22. They were then fed a ration consisting of corn silage, soybean hay, and grain until the hay feeding experiment began November 3. Because the quantity of hay available for the feeding trial was small, the cows were limited to an 8-day preliminary period and a 20-day experimental period on each kind of hay. The quantities of hay and grain consumed, milk and butterfat produced, and body weights are shown in Table 3. While such an experiment will show the relative palatability of the two hays and will give some indication of their value for the production of milk, it will not, of course, provide conclusive evidence of their relative value for extended feeding periods.

Palatability of Hay and Quantities Eaten.—The cows in this experiment did not eat as much hay as the cows in the 1935 experiment. Each cow was offered an excess of hay every day over what she would consume. The refused hay was weighed back once daily, and it averaged 15.0 per cent of the chopped hay offered and 14.5 per cent of the long hay.

Group A consumed 26.8 pounds of chopped hay per cow daily during the first period and 25.7 pounds of long hay during the second period. Group B consumed 28.5 pounds of long hay per cow daily during the first period and 25.2 pounds of chopped hay during the second period. For both groups, consumption of long hay averaged 27.1 pounds per cow daily, while consumption of chopped hay averaged 26.0 pounds. The excess of hay offered may have been responsible for the greater consumption of the long hay than of the chopped hay, because the long hay afforded better opportunity for the cows to select the choice portions. For this reason, both hays can perhaps be considered equal in palatability.

Production.—The difference in production on the two kinds of hay was very slight—probably no greater than would be expected from similar groups similarly fed. For this reason the difference is not significant and does not indicate a superiority of one hay over the other.

TABLE 3

Summary of feed eaten, production of milk and butterfat, and body weights

	TOTAL FEEDS EATEN BY GROUP			TOTAL PRODUCTION BY GROUP		INCREASE (+) OR DECREASE (−) IN MILK PRODUCTION	BODY WEIGHT	
	Concentrates	Hay	Total digestible nutrients	Milk	Butterfat		Average per cow	Average gain per cow
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Per cent*	*Pounds*	*Pounds*
Chopped hay:								
First 20-day period (Group A)	600.0	1,607.9	1,262.4	2,007.2	70.13	+4.6	1,236	14
Second 20-day period (Group B)	500.0	1,513.2	1,140.2	1,571.0	59.21	−4.4	1,144*	12
Total	1,100.0	3,121.1	2,402.6	3,578.2	129.34	+0.1†		13
Long hay:								
First 20-day period Group B)	520.0	1,707.7	1,262.2	1,669.1	59.76	+0.1	1,150	11
Second 20-day period (Group A)	559.0	1,544.7	1,207.3	1,847.8	67.04	−0.1	1,251	12
Total	1,079.0	3,252.4	2,469.5	3,516.9	126.80	0.0†		12

* Average for 2 cows. One cow's weight was not normal because of hip injury.
† Average for 20-day period.

Group A produced 33.5 pounds of milk and 1.17 pounds of butterfat per cow daily on the chopped hay during the first period, and 30.8 pounds of milk and 1.12 pounds of butterfat on the long hay during the second period. Group B produced 27.8 pounds of milk and 1.00 pound of butterfat per cow daily on the long hay during the first period, and 26.2 pounds of milk and .99 pound of butterfat on the chopped hay during the second period.

For both groups, production averaged 29.9 pounds of milk and 1.08 pounds of butterfat per cow daily on the chopped hay, and 29.3 pounds of milk and 1.06 pounds of butterfat on the long hay. Apparently the two hays were equal in value for milk production. The quantity of grain fed averaged 9.2 pounds per cow daily on the chopped hay, or 1 pound for each 3.25 pounds of milk; and 9.1 pounds on the long hay, or 1 pound for each 3.22 pounds of milk.

Decline in Production.—The rate of decline in production during the 20-day experimental periods, as shown in Table 3, is practically the same for the two hays. The percentage of decline was calculated from the first 3 and the last 3 days of each 20-day period. Group A cows increased 4.6 per cent in milk production on the chopped hay during the first period, with only a 0.1 per cent decline on the long hay during the second period. Group B cows increased 0.1 per cent in milk production on the long hay during the first period, with a decline of 4.4 per cent on the chopped hay during the second period. The slight difference in the declines is not sufficient to indicate the superiority of one hay over the other.

Body Weights.—Group A cows weighed more on an average than Group B cows. One Group B cow received a hip injury during the period she was on chopped hay. This injury affected her weight considerably, but had little or no effect on her feed consumption or milk production. The weights for Group B cows on chopped hay are therefore based on an average of two animals instead of three. The normal weight of the injured cow was within 5 pounds of the average of these two animals.

Group A cows gained 0.7 pound per head daily during period 1 (on chopped hay) and 0.6 pound during period 2 (on long hay). Group B cows gained 0.55 pound per head daily during period 1 (on long hay) and 0.6 pound during period 2 (on chopped hay). For both groups, the average gain per head daily amounted to 0.65 pound on chopped hay and 0.60 pound on long hay.

DISCUSSION

The present investigation, together with the 1935 experiment (1), emphasizes the point that high temperatures developed in storage are more destructive to the carotene content in both high and low moisture alfalfa hays than low temperatures. The work of the California station (2) also shows temperature to be a major factor in loss of carotene in alfalfa hay or meal during storage. Excess moisture in hay brings about conditions favorable for oxidation and excess heating in hay. To preserve the color and carotene content

of stored hay it is necessary to reduce the moisture content of the hay, before storing, to a point where excess heating will not take place under the storage conditions used.

In the 1935 experiment, long first-cutting hay with a moisture content of 25 per cent, stored in a mow to a depth of over 8 feet, reached a maximum temperature of 120° F., remained above air temperature for a 3-week period, and lost 93 per cent of the carotene it contained. Coarsely chopped hay of the same moisture content which was similarly stored, reached a maximum temperature of 128° in 19 days, did not return to air temperature for 2 months, and lost 95 per cent of its carotene.

In the present experiment, coarsely chopped hay with 15.8 per cent moisture that was stored in a mow to a depth of 7½ feet, lost considerably more carotene than long hay from the same lot that was stored under the same conditions. The chopped hay, reaching a maximum temperature of 106° which declined to 76° in 16 days, lost 72.8 per cent of its carotene during the 150-day storage period; whereas, the long hay, reaching a maximum temperature of only 81° which declined to 72° in 2 days, lost only 58.0 per cent of its carotene in 150 days of storage. It is apparent that there is a direct relationship between the temperatures attained in storage and the losses of carotene.

SUMMARY AND CONCLUSIONS

On June 3, 1936, first-cutting alfalfa hay containing 15.8 per cent moisture, nicely cured without rain or excessive loss of leaves, was stored in an open mow to a depth of 7½ feet in both the coarsely chopped and natural long forms. The hay was left in storage for 150 days.

Two and a half times as much hay was put in a given space in the chopped form as in the natural long form.

The long hay attained a maximum temperature of 81° F. the day after it was stored and declined to 72° in 2 days. The chopped hay reached a maximum temperature of 106° in 2 days and declined to 76° in 16 days.

The carotene content of both the long and the chopped hay was 76 parts per million of dry matter at the time of storage. After 150 days of storage the carotene content of the long hay was 31.9 parts per million and that of the chopped hay 20.7.

After 5 months of storage, the long hay had 54 to 57 per cent as much green color as the greenest grade of alfalfa hay and the chopped hay had 47 to 48 per cent as much.

Both the long hay and the chopped hay in this experiment lost green color at a slower rate than they lost carotene.

In the investigation of the previous year with chopped hay containing 25 per cent moisture, the green color was completely destroyed and the final carotene was only one-fifth as much as in the chopped hay in this investigation.

Dry matter losses were moderate and about equal in both kinds of hay. The chopped hay was as palatable as the long hay.

The quantities of milk produced and the maintenance of milk flow were very slightly in favor of the cows fed the chopped hay, in spite of their slightly lower consumption of nutrients as estimated from actual analyses. However, these slight differences in production might be expected with hay that is practically identical in quality.

This investigation indicates that hay with 16 per cent moisture will lose more of its color and carotene if stored in a chopped form than if stored in a long form.

The results of the 2 years' work show that the chopping of field-cured alfalfa at the time of storage in a mow is practicable if precautions are taken to see that the hay is not too high in moisture content. The principal advantages of chopping are: (A) More hay can be stored in a given space; (B) less work is required in the mow at the time of storage; (C) the hay can be removed from the mow more easily; and (D) in the case of stemmy hays, consumption is more complete because the leaves are not so readily selected from the chopped hay as from long hay.

To insure success with chopped hay certain precautions must be observed. In the first place the hay to be chopped should be dried in the field to a low moisture content. While this is important when the hay is to be stored in the usual way, it is doubly important when the hay is to be chopped. Furthermore, the hay should be chopped into $\frac{3}{4}$-inch lengths or longer. If these precautions are observed, the quality of hay made by storing it in a chopped form will be approximately equal to the quality of hay made by storing it in the natural long form, except that even under the best practicable conditions the chopped hay will still lose more of its color and carotene than the long hay.

Both high-moisture content and fine chopping increase the temperature of stored hay and lead to excessive destruction of color and carotene and to a lowering of the feeding value. Under certain conditions the temperature may become high enough to make the chopped hay a fire hazard.

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American Dairy Science Association Announcements

THIRTY-THIRD ANNUAL MEETING, OHIO STATE UNIVERSITY, COLUMBUS, OHIO AND OHIO AGRICULTURAL EXPERIMENT STATION, WOOSTER, OHIO, JUNE 14–17, 1938

Monday—June 13

1 P. M.–9 P. M.—General Registration.

Tuesday—June 14

8 A. M.–10 A. M.—General Registration and Room Registration.
10 A. M.–12 NOON—Opening Session—H. W. Gregory, Presiding.
1 P. M.–2:30 P.M.—General Session—(Instruction).
2:30 P. M.–4:30 P. M.—Sectional Meetings:
Manufacturing Section, Dairy Products Judging Conference for Coaches and Instructors.
Production and Extension Sections. Symposium on Nutrition.
4:30 P. M.—Meeting of the Board of Directors, and Committee Meetings.
8:30 P. M.—Social Hour.

Wednesday—June 15

8 A. M.–10 A. M.—General Registration and Room Registration.
8 A. M.– 9:30 A. M.—Sectional Committee Meetings.
8 A. M.–9:30 A. M.—Inspection of Extension Exhibits.
9:30 A. M.–12 NOON—Sectional Meetings.
12 NOON–1 P. M.—Dairy Luncheon.
1 P. M.–4:30 P. M.—Sectional Meetings.
8 P. M.—Entertainment.

Thursday—June 16

8 A. M.–9 A. M.—Committee Meetings.
9 A. M.–11:30 A. M.—Sectional Meetings.
11:30 A. M.–12 NOON—Sectional Business Meetings.
1 P. .M.–3:30 P. M.—Sectional Meetings.
3:30 P. M.–4:30 P. M.—General Business Meeting.
6:30 P. M.—Annual Banquet.

Friday—June 17

Wooster, Ohio

10:30 A. M.–12 NOON—General Session—Earl Weaver, Presiding.
12 NOON–1 P. M.—Luncheon.
1 P. M.—Points of Interest at the Ohio Agricultural Experiment Station.

Members of the Association are invited to submit titles and abstracts of papers dealing with original investigations. Those interested in presenting

papers should refer to page 789 of the December, 1937 number of the JOURNAL for pertinent information. Time allotted for each paper limited to 10 minutes. Titles and abstract of papers must be in the hands of the chairman of the program committee by April 15.

All communications relative to the program should be addressed to Dr. T. S. Sutton, Department of Animal Husbandry, Ohio State University, Columbus, Ohio.

EXTENSION SECTION COMMITTEES—1938

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NOMINATIONS FOR THE 1938 BORDEN AWARDS FOR CONTRIBUTIONS IN THE DAIRY PRODUCTION AND DAIRY MANUFACTURING FIELDS

The recipients of the two annual Borden Awards, each consisting of $1000 and a gold medal, for the most meritorious research in the field of dairy cattle production and the field of dairy manufacturing, will be selected by the awards committee of the American Dairy Science Association. Please send your nominations for these honors to the Secretary of the American Dairy Science Association, Dept. of Dairy Technology, Ohio State University, Columbus, Ohio, so that they will reach him not later than March 1, 1938. The awards will be made for (1) the most outstanding research work in the field of dairy production, breeding, feeding, or farm sanitation and other

phases of production work, and (2) for outstanding research in the field of dairy manfacturing, such as improvement in equipment or methods in the handling of milk or its products and the production of milk products. Nominations should be made for those whose work has been completed and published during the five year period ending December 31, 1937.

Those who are eligible for consideration for the awards must be under forty years of age at the time of the award.

Since Borden awards are also being made for meritorious work in basic science as related to, or as it affects the Dairy Industry; for work in basic research on vitamins or other nutritional aspects of milk products; for work in the practical application of the findings in nutritional research; and for work in public health as related to the Milk Industry, these awards to be administered by other scientific societies, these phases of research work as applied to the dairy industry should not be considered in making your nominations for research in the production and the processing fields.

Each member of the American Dairy Science Association is entitled to make nominations for these awards. Please give the following information in your nominations:

I, the undersigned member of the American Dairy Science Association nominate.....for the Borden award for 1938 in the field of dairy production, dairy manufacturing for his contribution entitled .....and delivered before.....,
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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

49. Researches on the Identification of Cocoa Fat (Cocoa Butter or Cocoline) in Butter. L. Hoton. Le Lait *17*, 161, p. 19, Jan. 1937.

None of the various fat indices in themselves are satisfactory for determining the adulteration of butter with 10 per cent or less cocoa butter as these indices in butter alone show sufficient variation to conceal the effects of the addition of 10 per cent cocoa butter. By combining several of the indices a value may be obtained by which 10 per cent of added cocoa butter can be detected. Thus the index of volatile soluble acids in butter is 30 and that of the volatile insoluble acids is 2.5 and the refractive index of the latter is 20. If 10 per cent of cocoa butter is added to the butter, these values theoretically become 28, 3.5 and 17 respectively. For butter the product of the index of the soluble volatile acids and the refractive index divided by the index of volatile insoluble acids is 24 while, when the butter contains 10 per cent of added cocoa butter, the value becomes 13.6. It is believed that a value of 20 or above calculated as given may be taken to indicate pure butter fat. As an indication of the presence of cocoa butter the value should be 15 or lower. Values between 15 and 20 are doubtful cases. Twenty of such doubtful cases were found on the analysis of 156 samples. The method thus allows the detection of adulteration with 10 per cent of cocoa butter in a majority of cases. A.H.J.

CHEESE

50. Reasons for Authorizing Sudan IV for the Coloration of Cheese Surfaces. Jean Pien, Paris, France. Le Lait *17*, 162, p. 123, Feb. 1937.

Alkanet is the only fat-soluble dye that is an authorized food color in France. This dye is not satisfactory when used for coloring cheese rinds. It is variable in color and has different colors at different H ion concentration. Moreover, when dissolved in paraffin and the paraffin heated to 130° C. to 150° C. (266° F. to 302° F.) which is the desirable temperature for applying the paraffin to the cheese, the dye is discolored. Sudan IV is not subject to these disadvantages. When fed to rats at the rate of 1 milligram per day Sudan IV was shown to have no ill effects. Also the cheese rind is not consumed but is cut from the cheese and discarded. The Dutch have been using Sudan IV to color their cheeses for a long time and no ill

effects have been reported. It is recommended that Sudan IV be approved as a dye for the paraffin that is applied to cheese surfaces. A.H.J.

51. The Salting and Cooking of Curds in the Manufacture of Several Varieties of Cheeses. J. C. MARQUARDT, N. Y. Agr. Exp. Sta. Geneva, N. Y. Bull. 670, July, 1936.

A study has been completed associating the composition and quality of five varieties of cheese with variations in salting and cooking methods.

The study revealed that cheese curds should be salted at a rate based upon the milk fat content of the milk used.

Cook variation studies added fundamental knowledge useful for further investigations dealing with cheese improvement.

The study indicated that comparable milks made into cheese produced quality cheeses upon the basis of the cheese variety made, with cheddar first followed in order by granular, Monterey, and brick.

The study indicated that quality and uniformity could not be regularly expected when making cheese by the Camosum method from the type of milk generally available. J.C.M.

52. Methods of Making Cheddar Cheese from Milk with a Low Curd Tension Due to Latent Mastitis. J. C. MARQUARDT AND G. J. HUCKER, N. Y. Agr. Exp. Sta., Geneva, N. Y. Tech. Bull. 242, April, 1937.

It is generally agreed that a high quality cheddar cheese cannot be made from milk produced by cows with an active mastitis infection. However, since the udder tissues of practically all cattle harbor the streptococcus associated with the common type of bovine mastitis, the infection exists either in a latent or a chronic condition in almost all producing herds.

This investigation has shown that even where the milk contains demonstrable numbers of mastitis streptococci and more than 500,000 leucocytes per cc., the milk can be made into satisfactory cheddar cheese though it may lack in normal curd-formation properties. This was accomplished by the addition of 1½ to 3 per cent of starter, or by the addition of 30 per cent hydrochloric acid at the rate of 100 cc. per 1,000 pounds of milk with a smaller amount of starter.

The study has revealed the necessity and importance of using a test like the Marschall cup test in making cheese from milk whose curd tension varies from normal. It has been established that after 9 months of curing, *Streptococcus agalactiae* were present in the cheeses made from the experimental milk with a low curd tension.

Unless even latent or chronic conditions of mastitis are eliminated from cheese milk herds or the milk is especially handled during the making, losses may be experienced. J.C.M.

CHEMISTRY

53. The Identification of Neutralized Milk. M. R. BAETSLE. Dir. of the Lab. for Chemistry and Bacteriology of the City of Gand. Le Lait *17*, 162, p. 141, Feb., 1937.

Various methods of determining whether sodium bicarbonate or sodium carbonate have been added to milk in order to neutralize lactic acid are reviewed. These methods are in general unsatisfactory or of doubtful value. Since the sodium content of milk is relatively constant the investigator recommends its determination in order to ascertain neutralization and the extent of such neutralization. The sodium to phosphate ratio may also be of value in determining neutralization. Various methods of determining sodium are discussed. Since all such methods require much time a short method for detecting neutralized milk is desired. Such a method consists in adding 30 cc. of methyl alcohol to 20 cc. of milk. If the milk has not been neutralized, rapid coagulation will take place and clear serum will form. If the milk has been neutralized, coagulation will not take place and the serum will be turbid. Moreover the serum from neutralized milk will have a pH value of 6.5 or above sometimes as high as 8.5. Very fresh milk may not curdle rapidly to yield curd and clear serum but the pH value of the serum will serve to indicate whether or not it has been neutralized. A.H.J.

54. The Ammonia Content of Milk and Its Determination. S. NIEMCZYCKI AND K. GERHARDT, Inst. of General Chemistry and of Dairy Science of the Academy of Veterinary Medicine at Lwow, Poland. Le Lait *16*, 160, p. 1050, Dec., 1936.

The ammonia was removed from milk by distillation under vacuo at 40° C. (104° F.). The ammonia in the distillate was determined by Nesslerization. In 43 samples of fresh milk the quantity of ammonia varied between 0 and 2.18 milligrams per liter, the average being 0.75 milligram per liter. The ammonia content of milk from the individual quarters of the same cow at the same milking showed appreciable variation just as in the milk of different cows. The heating of milk above 45° C. (113° F.) results in increasing the ammonia content of the milk due to decomposition of the protein. The ammonia contents of pasteurized, sterilized, and condensed milks are being determined. A.H.J.

55. Casein as a Primary Material for the Chemical Industry. G. GENIN, Paris, France. Le Lait *16*, 160, p. 1083, Dec., 1936.

The chemical composition of rennet casein and of acid and natural sour casein is given. Differences in chemical properties of the various types of casein are described. Various uses of casein in industry are described and the properties of the caseins for specific uses are discussed. A.H.J.

56. The Phosphatide Content of Milk. BRUNO REWALD. Le Lait *17*, 163, p. 225, March, 1937.

The methods that have been used for determining the phosphatide content of milk have yielded variable results. A new method is therefore proposed. Whole milk powder is first prepared from milk. A kilogram of this powder is subjected to 8 extractions with cold acetone in order to remove the true fatty material. (220 grams of fatty material were obtained. This showed only minimal traces of phosphorus.) After evaporation of the acetone, the fat-free powder was subjected to an extraction with a mixture of methyl alcohol and ethyl alcohol, first cold then hot. This operation was repeated 5 times. However, as phosphatides were not completely removed, 3 other extractions were made with a mixture of 80 parts of ethyl alcohol and 20 parts of benzol. Additional quantities of phosphatides were thereby extracted. At the same time considerable quantities of sugar were extracted. The extracts were combined, cooled and then filtered and the residue washed several times with the alcohol-benzol mixture and finally with pure benzol. The alcohol and benzol were removed by evaporation and the residue dried under vacuo and then taken up in benzol. An oily mass was thereby obtained indicating that considerable fat had remained in the milk powder to be subsequently extracted in the phosphatide extractions. The fat was extracted and the phosphatides precipitated by the addition of acetone. The precipitate was filtered off, then dissolved in benzol and a precipitate again obtained by the addition of acetone. The total phosphatides obtained on repeated purifications with acetone was 2.4 grams of which the phosphorus content was 3.92 per cent. In the mixture of phosphatides 58.3 per cent were soluble in ethyl alcohol and 41.7 per cent were insoluble in alcohol. The phosphorus content of the alcohol soluble fraction (lecithin) was 3.61 per cent and of the alcohol insoluble fraction (kephalin) was 3.9 per cent. Neither the lecithin nor the kepalin are pure products but mixtures of similar substances. These researches show that the phosphatide content of dry whole milk was 0.24 per cent. If the total solids content of fluid milk is 87 per cent, the phosphatide content of fresh milk would be 0.0314 per cent. The content of lecithin soluble in alcohol would be 0.0131 per cent. A.H.J.

57. A Study of the Fatty Matter in Goat's Milk. Its Eventual Application to the Investigation of Mixtures of Goat's and Cow's Milk. ANDRE CHOLLET AND ANDRE CAMUS. Contribution from the Professional School of Dairy Surgeons. Le Lait *17*, 162, p. 135, Feb., 1937.

The Crismer index is lower and the index of saponification is higher in butter from goat's milk than in butter from cow's milk although higher saponification indices are sometimes encountered in butterfat from cow's

milk. The Planchon index is notably lower in fat from goat's milk but there were wide variations of this index in the several samples investigated. The iodine number of the fat from goat's milk is in general higher than in the fat of cow's milk but the values are within the range encountered in fat from cow's milk. The variations in the Amagat and Jean oleorefractometer values are the same for the fat from both cow's and goat's milk. The soluble volatile acids are lower and the insoluble volatile acids are higher in goat's milk fat than in cow's milk fat. The ratio of the insoluble volatile acids to the soluble volatile acids in the fat is suggested as a means of detecting mixtures of cow's and goat's milk. Thus in fat from cow's milk this ratio varies from 8 to 15 while in goat's milk the variation in ratio is from 36.5 to 43.1. A.H.J.

58. A Rapid Method for Determining Total Nitrogenous Matter in Milk for Use in Milk Control. A. M. LEROY, Chief of Zootechnical work at the National Inst. of Agronomy. Le Lait *17*, 163, p. 230, March, 1937.

To 10 cubic centimeters of neutralized milk in a test-tube are added 1 cubic centimeter of neutral formaldehyde and then 10 cubic centimeters of a standard alkali solution. The pink color of the mixture in the test-tube is then compared with color standards calibrated in terms of milligrams of nitrogen per liter of milk. In 35 per cent of the samples tested the agreement between this colorimetric method and the micro Kjeldahl method was within $\pm$ 0.5 milligram of nitrogen, in 32 per cent of the tests the variation was 1.0 milligram of nitrogen per liter. The variation was greater than 2.5 milligrams of nitrogen per liter in 5 per cent of the tests. A.H.J.

CONCENTRATED AND DRY MILK

Abstracts of interest are numbers 53, 54, 56, 59, 60, 67, 71, and 72.

FOOD VALUE

59. Vitamins and Sterilization Under Vacuo. JEAN PIEN, Paris, France. Le Lait *17*, 161, p. 27, Jan., 1937.

There are two groups of methods used in preserving foodstuffs, methods which prevent the proliferation of bacteria actually present and methods which destroy the micro-organisms present and prevent subsequent contamination. The first group of methods includes preserving by cold, by drying and by the use of sugar, salt, etc. The second method involves the use of heat to sterilize the product. The effects of sufficient heat to allow sterilization of food products are discussed. Vitamins B_2, D and E are not materially reduced in potency even in the presence of oxygen. Vitamins A, B_1 and C are not affected to any marked extent by heating if care is taken

to prevent oxidation. A group of rats was divided into two groups, one being fed on fresh materials, the other on materials sterilized in the absence of oxygen. At the end of 5 months, the rats on fresh foods weighed 288 grams on the average while those on sterile food averaged 277 grams. The lower weight of the rats fed on the sterile diet is not thought to be due to poorer food value but to the fact that the rats ate less of it due probably to it not being so palatable as a result of the sterilization treatment.

A.H.J.

60. The Increase in the Antirachitic Properties of Milk by Irradiation. G. GENIN, Paris France. Le Lait *17*, 161, p. 47, Jan., 1937.

Accompanying the increase in antirachitic power of milk as a result of irradiation is an off-flavor of the milk. Light of wave lengths between 3100 and 2600 Angstrom units was found to be less effective in causing the development of the off-flavor in milk than light of wave length below 2600 Angstrom units. A.H.J.

ICE CREAM

61. Outline of Activities of the International Association of Ice Cream Manufacturers for the Year 1937. ROBERT C. HIBBEN, Int. Assn. of Ice Cream Mfrs., Washington, D. C. November, 1937.

The principal activities of the International Association of Ice Cream Manufacturers for the year 1937 are outlined in this bulletin. A report of the activities of the affiliated organization, The Ice Cream Merchandising Institute, is also included. M.J.M.

62. Ice Cream Sales Index. Statistical and Accounting Bureau, Int. Assn. of Ice Cream Mfrs., 1105 Barr Bldg., Washington, D. C. November, 1937.

This bulletin contains an analysis of ice cream sales in 1937 compared with 1936 for the United States and Canada. The survey covers the sales for the first eight months of the year. During this period of eight months, sales in 1937 for the United States were 9.15 per cent greater than in the same months of 1936. For Canada, the increase was 14.83 per cent.

M.J.M.

63. Selling Ice Cream via Refrigerated Dispensing Machines. Anonymous. Ice Cream Rev. *20*, 12, p. 28, July, 1937.

Ice cream can be dispensed successfully through dry ice refrigerated dispensing machines. Two machines operated in the New York subway during three winter months averaged 140 five cent packages per machine per day. Cost of refrigeration averaged 20 cents a day. The machine

described in the article was perfected in Holland and handles chocolate covered ice cream bars. J.H.E.

64. Plastic Cream. L. P. SHARPLES, Milk Processes Inc., Philadelphia, Pa. Ice Cream Rev. *21*, 1, p. 31, Aug., 1937.

Plastic cream is cream of 80 to 83 per cent butterfat content with the fat in the dispersed phase of the emulsion, as contrasted with butter which has the fat in the continuous phase of the emulsion. To make plastic cream, fluid cream of any given fat content is heated, and then passed through a special centrifugal separator. It is then pasteurized and passed over a special stainless steel drum cooler. Plastic cream has many uses which include a cheap means of transporting cream, a cheap means of storing cream, for making ice cream, for making cream cheese, for making flavored spreads. It has proven especially adaptable as a fat source for ice cream.

J.H.E.

65. Plant Paint Problems. MILTON W. LIGHTCAP, Pittsburgh Plate Glass Co., Pittsburgh, Pa. Ice Cream Rev. *21*, 1, p. 46, Aug., 1937.

Some of the special paint problems facing the ice cream manufacturer and suggestions for solving them are given. J.H.E.

Other abstracts of interest are numbers 49, 53, 54, and 56.

MILK

66. The Maintenance and Cleaning of Milking Machines. G. GENIN, Paris, France. Le Lait *17*, 162, p. 147, Feb., 1937.

The use of milking machines is not very extensive in France due to former difficulties experienced with the machine, particularly with the rubber parts. Satisfactory rubber parts have now been developed so that they can be cleaned and sterilized without being damaged. Cleaning and sterilizing with hot water, steam and hot alkaline solutions are recommended. Sterilizing with chemical disinfectants is not as satisfactory as sterilizing by other methods as the disinfectants, particularly chlorine compounds, are corrosive and reduce considerably the serviceable period of the rubber parts.

A.H.J.

67. Mastitis. IV. The Composition of Milk as Affected by Latent Mastitis. A. C. DAHLBERG, J. J. KUCERA, J. C. HENING, AND G. J. HUCKER. N. Y. Agr. Exp. Station, Geneva, N. Y. Tech. Bul. 239, Nov., 1936.

Earlier investigations indicate that the chemical composition of abnormal mastitis milk is quite different from that of milk normal in appearance. More recent work indicates that a latent mastitis infection may be present

in the udder without causing any visible change in the milk. The present investigation was undertaken to determine whether there is a demonstrable relationship between the degree of infection and the chemical composition of milk normal in appearance.

Only cows having udders free from active inflammation and whose milk was normal in appearance were selected for study. These cows were divided into three groups, *viz.*, (A) no demonstrable infection, (B) slight infection and (C) pronounced latent infection but milk normal in appearance.

Composite milk samples of complete milkings from each of these groups were submitted to detailed chemical analysis. During the course of the study samples of fore-milk from each quarter of each cow were studied by bacteriological tests to determine the amount of infection present.

Only slight differences in the chemical composition of the mixed milk of these groups were found, regardless of the degree of infection, as long as the milk remained normal in macroscopic appearance. The slight differences in chemical composition included a decrease in lactose, specific gravity, skim-milk solids and curd tension while the chlorides and albumins were slightly increased. These changes in composition were not greater than variations in chemical composition of milk between two herds of the same breed.

It is concluded that milk normal in appearance is essentially normal in chemical composition. If no milk is included from inflamed, congested or injured quarters, the chemical composition of the milk from a herd will be normal in chemical composition.

It follows that earlier investigations on the chemical composition of normal milk were not affected by the possible presence of latent mastitis.

A.C.D.

68. Milk. Lancet *233*, 327, Aug. 7, 1937.

In the British Government's recently announced policy for milk, bonuses are to be paid by the Exchequer for quality milk, including accredited milk at 1¼d. a gallon, and tuberculin-tested milk at 1d. a gallon for the next three years.

Of most direct concern to public health authorities and the medical profession, however, is the Government's intention that any local authority shall be able to apply to the Minister of Health or the Secretary of State for Scotland for an order requiring efficient pasteurization of milk retailed in its area, although two years would lapse before the order would take effect, and milk from tuberculin-tested herds and sterilized milk would be exempt, and milk retailed from dairies supplied by a single herd would be exempt for three years.

If advantage is taken of these powers, says the editorial, Great Britain will have gone far to put the milk in its proper place as a food, and the medical profession will confidently recommend its wider consumption.

J.A.T.

69. Vacuum Milk Cooler. JOHN E. NICHOLAS, Dept. of Agr. Eng., The Penn. State College. Refrig. Eng. *31*, 6, p. 367, June, 1936.

This method of cooling is obtained by drawing a high vacuum on the milk container. Thus cooling is done by evaporation of some of the water in milk, or approximately three pints from every 10-gallon can, when cooled through a temperature range of nearly 40 degrees. This method of cooling is more expensive than the direct immersion method, and is slower, but has the advantage of cooling the entire contents uniformly. W.D.S.

70. The Supply and Utilization of Milk in Pennsylvania. T. K. COWDEN AND E. G. FOUSE. Penn. Agr. Exp. Sta., The Penn. State College Bull. 327, April, 1936.

During April, 1934, the milk dealers operating in Pennsylvania handled 323,000,000 pounds of milk and cream. Of this amount, 83 per cent was purchased as whole milk from producers. Sales of milk for fluid use amounted to 58 per cent of the total handled, for fluid cream 12 per cent, and that used in manufacturing 30 per cent. Farmers' organizations controlled 40 per cent of the total volume handled by all dealers. Shipments of milk and cream to dealers in other states amounted to 71,000,000 pounds, which exceeded by 26,000,000 pounds the amount received from out-of-state sources. W.D.S.

71. Change in Color of Winter Milk Natural. W. E. KRAUSS, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Agr. Exp. Sta. Weekly Press Bull. No. 22, Sept. 16, 1937.

No concern need be felt by the consumer over the progressive decrease in the yellow color of milk during the winter. This is a natural change resulting from the cows' decreased intake of carotene from the types of roughage usually available for winter feeding. In order to compensate for this drop in yellow color and hence vitamin A activity it is suggested that more milk be consumed, that the use of other vitamin A-rich foods be increased, or that standard vitamin A preparations be considered. W.E.K.

72. The Influence of the Feed Given to Dairy Cows on the Production of Milk of Good Industrial Quality. H. L. BERARD, J. M. ROSELL, AND JULES TURGEON, Dept. of Bacteriology of the Agr. Faculty, Montreal, Canada. Le Lait *16*, 160, p. 1068, Dec., 1936.

Milk of undesirable odor and taste is produced when the cows consume garlic, onion, turnip, leek, wormwood, potatoes, lupin, clover, sugar beet waste, etc. If the consumption of such material is four hours or more before milking, the possibilities of the milk being undesirable in flavor are considerably reduced. However, it is best to eliminate all such feeds as well as molded or spoiled feeds from the ration. Feeds which increase the per-

centage of oleine in the butterfat produce a soft butter. Among such feeds are linseed and soya cake, corn gluten, oats, wheat bran, and green forage. On the contrary, the feeds that reduce the percentage of oleine have an opposite effect, *i.e.*, they produce a butter that is too firm or too dry. Among such feeds are potatoes, wheat of India, corn silage, sugar beets, cottonseed cake, hay and alfalfa. By choice of the proper feeds, summer and winter butters may be given the desired physcial properties. Certain ensilages and sugar beets alter the fermenting predisposition of milk in such a way as to render it nonadaptable for manufacturing purposes. Such milk should be used for immediate consumption and not for the manufacture of butter and cheese. For the production of certain types of cheese it is necessary to control carefully the feed of the cow. In this connection the Swiss regulations for forage and forage management are given. A.H.J.

Other abstracts of interest are numbers 49, 53, 54, 56, 58, 59, and 60.

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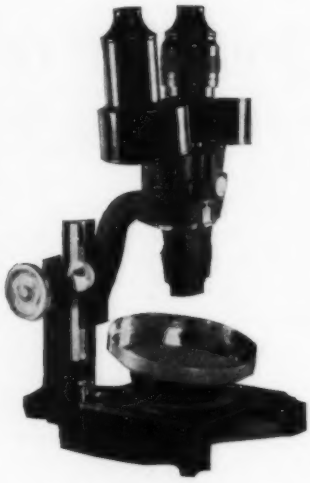

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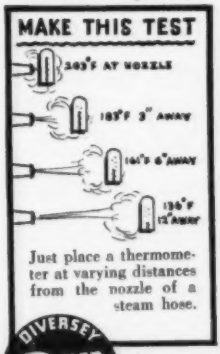
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